



NTH Consultants, Ltd.

Infrastructure Engineering
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Arnold E. Leder
USEPA Region V
77 West Jackson Boulevard
Chicago, IL 60604-3590

July 2, 2004
Proj. No. 13-020064-20

**RE: Walnutdale Farms
Volume Calculations**

Dear Mr. Leder:

We have completed the design volume calculations for the new storm water storage structure. The following details our design process and the attached documents our calculations.

We have analyzed the sub-watersheds that contribute runoff to the northwest corner of the farm. This analysis differs from May and Associates' based on clean water diversions that will be implemented.

Sub-watershed Delineation

The sub-watersheds are represented on the attached map and described below.

- Sub-watershed A
 - The areas that contribute runoff to catch basins AA, X, Y, and Z.
 - A collection header will be installed north of barns G-6, G-7, and G-8A. The header will connect to the outlets from catch basins AA and Y, and connect them to the storage structure.

- Sub-watershed B
 - The area east of Pit 5 and Pit 6, the actual silage storage area, was previously delineated as area contributing to the storage needs of the existing storage structure to the east. Nonetheless, this area will be counted again; as contributing to runoff for the new structure.



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- The existing water collection area/Solids Trap west of the silage pad will be lined with concrete so that it may be used as a reception/pump-out pit, continue to be used to filter solids, and the solids can be more readily removed.
- The cattle walkway connecting the west side of the Freshing Barn to the west end of Pit 6 will be diverted into the solids trap.

- Sub-watershed C
 - The drain from catch basin FF follows the perimeter of the milking parlor along the west side and collects the water in that general area shown.
 - The remaining clean water will be diverted away from the storage structure and/or transfer components.

- Sub-watershed D collects the area shown and eventually flows into the solids trap (Sub-watershed B).

Storm Water Modeling

We used the HEC-HMS 2.2.2 (HEC) model to calculate the 25-year, 24-hour storm water storage requirement and maximum flow rate from the solids trap, Sub-watershed A, and Sub-watershed C. Information provided by May and Associates' survey was used to enter detailed information about the conveyances in the model. The storage requirements for the 25-year, 24-hour storm are 440,000 gallons (59,000 ft³). A summary outlining the peak discharge, total runoff volume, and drainage area for each sub-watershed is attached in Appendix A.

Storage Sizing

Animal Waste Management 2.0.2 (AWM) software was used to determine seasonal six-month storage requirement. The Michigan climate data for Allegan County in AWM was used to calculate the six-month storage requirement and the precipitation minus evaporation for November to April. The storage requirement for the average six-month runoff is 1.5 million



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gallons (198,000 ft³). Output from AWM and our calculations for precipitation minus evaporation are attached in Appendix B. It should be noted that we are using AWM only as a design tool to determine six months of runoff based on the areas delineated on the attached map and for precipitation minus evaporation data. Therefore, the surface area of this structure is not indicative of the actual design.

Storage Requirements

Assuming a length and width of 300 ft by 200 ft (60,000 ft² surface area) and a depth of 6.5 ft, our preliminary determination for total six-month storage is 3 million gallons (390,000 ft³). It should be recognized that depending on the subsurface investigation the depth which effects the surface area, (which affects the volume requirements for the direct precipitation and ultimately effects the total volume) is subject to change. Calculations are included in Appendix C.

Two copies have been provided for additional review. If you have any questions or comments, please feel free to call me at (616) 957-3690.

Sincerely,
NTH Consultants, Ltd.

A handwritten signature in black ink, appearing to read 'TKrause', written over a light blue horizontal line.

Timothy C. Krause, EIT
Senior Staff Engineer

A handwritten signature in black ink, appearing to read 'MGroenleer', written over a light blue horizontal line.

Marc E. Groenleer, P.E.
Senior Project Engineer,
Project Manager

cc: Kevin Lettinga, Walnutdale Farms

Attachments

HMS * Summary of Results

Project : Walnutdale

Run Name : Run 5

Start of Run : 16Jun04 0800 Basin Model : Farmstead2
 End of Run : 17Jun04 1400 Met. Model : Farmstead Met
 Execution Time : 23Jun04 1229 Control Specs : Farmstead Control

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Catch Basin Z	0.34902	16 Jun 04 2028	0.058669	0.000
CB Z Conveyance	0.34892	16 Jun 04 2028	0.058669	0.000
Catch Basin AA	0.60378	16 Jun 04 2046	0.13492	0.001
Basin AA	0.90656	16 Jun 04 2038	0.19359	0.001
CB AA Conveyance	0.90653	16 Jun 04 2038	0.19359	0.001
Catch Basin X	0.30827	16 Jun 04 2003	0.024855	0.000
CB X Conveyance	0.30750	16 Jun 04 2003	0.024855	0.000
Catch Basin Y	0.60574	16 Jun 04 2037	0.11799	0.001
Basin Y	0.64548	16 Jun 04 2035	0.14284	0.001
CB Y Conveyance	0.64535	16 Jun 04 2036	0.14285	0.001
Subwatershed A	1.5507	16 Jun 04 2037	0.33643	0.001
A Conveyance	1.5507	16 Jun 04 2037	0.33643	0.001
Trap Shed	1.1056	16 Jun 04 2244	0.56981	0.002
op Shed	0.44971	16 Jun 04 2042	0.088353	0.000
Cattle Walkway Shed	0.15012	16 Jun 04 2048	0.034247	0.000
Subwatershed B	1.2069	16 Jun 04 2228	0.69241	0.003
B Conveyance	1.2069	16 Jun 04 2228	0.69241	0.003
Subwatershed D	0.98096	16 Jun 04 2051	0.22533	0.001
D Conveyance	0.98080	16 Jun 04 2051	0.22533	0.001
Solid Trap	2.0329	16 Jun 04 2055	0.91773	0.004
Trap Conveyance	2.0328	16 Jun 04 2055	0.91772	0.004
Subwatershed C	1.0592	16 Jun 04 2006	0.090543	0.000
C Conveyance	1.0582	16 Jun 04 2006	0.090547	0.000
Storage Structure	3.6160	16 Jun 04 2043	1.3447	0.006

*x 43560
 = 58,575 ft³*

Animal Waste Management Plan prepared for Walnutedale Farms

Designed By: Pete Wyckoff

Checked By: _____

Date: 06/22/2004

Date: _____

Farm Information

Data Source: NRCS

of Operating Periods: 1

Operating Period: January - December

Climate Data

State: MI

County: Allegan

Station: ALLEGAN MI0128

Year - 24 Hour Storm Event: 4.5 inches

Month	Prec. (in)	Evap. (in)
January	2.21	0.25
February	1.67	0.50
March	2.48	1.51
April	3.53	2.27
May	3.14	2.77
June	3.56	3.53
July	3.39	4.79
August	3.33	4.54
September	3.64	3.02
October	2.96	1.26
November	3.03	0.50
December	2.78	0.25
Totals	35.72	25.19

Lagoon Loadings:

Rational Design Method

Barth KVAL: 0

Load Rate For Odor, OCV: 0 lbs VS/cu. ft/day

LRV Max: 0.00625 lbs VS/cu. ft/day

NRCS Design Method

Anaerobic Load Rate: 0 lbs VS/1000 cu. ft/day

Runoff

Runoff Volume Method: Calculate Monthly Runoff Volumes with AWM

Pervious Watershed Area: 0.794995 acres

Pervious Curve Number Storm: 97

Pervious Curve Number Monthly: 87.95755 (1 day), 73 (30 day)

Impervious Area: 128772 sq. ft

Runoff Volumes (1000 cu. ft.)

	Pervious	Impervious	Monthly Totals
January	1.20	18.16	19.36
February	0.53	12.65	13.18
March	1.59	20.96	22.55
April	3.44	31.96	35.40
May	2.71	27.85	30.56
June	3.50	32.28	35.78
July	3.17	30.48	33.65
August	3.06	29.85	32.91
September	3.66	33.12	36.78
October	2.39	25.97	28.36
November	2.51	26.70	29.21
December	2.08	24.08	26.16
Total	29.84	314.06	343.90

25 Yr-24 Hr Storm	11.97	45.76	57.73
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Waste Facilities

Storage Pond #1

Design Dimensions

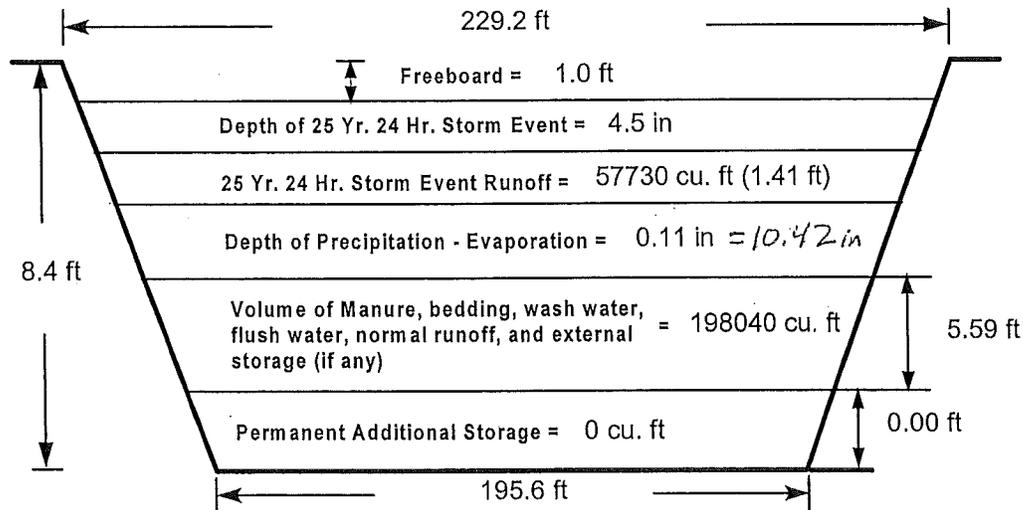
Shape: Rectangle
 Top Dimensions: 193.5 ft x 229.2 ft
 Bot Dimensions: 160.0 ft x 195.6 ft
 Sideslope: 2:1
 Storage Depth: 7.0 ft
 Final Depth: 8.4 ft
 Freeboard: 1.0 ft

Design Quantities

Depth of 25 Yr. Storm: 4.5 in
 Depth of Precip Minus Evap: 0.1 in
 Waste Volume: 198040 cu. ft
 Permanent Add'l Storage: 0 cu. ft

Water Budget (1000 cu. ft)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Withdrawal Months				X						X			
Waste Volume	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runoff	19.36	13.18	22.55	35.40	30.56	35.78	33.65	32.91	36.78	28.36	29.21	26.16	343.90
Precip-Evap	7.24	4.32	3.58	4.66	1.37	0.11	-5.17	-4.47	2.29	6.28	9.35	9.35	
Cum. Storage Vol	100.67	118.18	144.31	184.37	31.93	67.82	96.29	124.73	163.80	198.45	38.56	74.07	



	Precip	Evap	Difference
May	3.14	2.77	0.37
June	3.56	3.53	0.03
July	3.39	4.79	-1.4
August	3.33	4.54	-1.21
Sept	3.64	3.02	0.62
Oct	2.96	1.26	1.7
Nov	3.03	0.5	2.53
Dec	2.78	0.25	2.53
Jan	2.21	0.25	1.96
Feb	1.67	0.5	1.17
March	2.48	1.51	0.97
April	3.53	2.27	1.26
Totals	35.72	25.19	10.53

Season Difference

Summer 0.11

Winter 10.42

Input data from the Animal Waste Management Plan model.



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Job	Walnutdale	Project No.	13-020064-26	Sheet No.	1
Subject	Storm Water Storage Pond	By	Pete Wyckoff	Date	6/17/04
		Checked By		Date	

Unknown: Total storage volume required for to design Storm Water storage pond.

Given: 25 year 24hr storm = 4.45 in.
 Runoff volume produced from 25 year/24hr storm = 58575 ft³ (HEC-HMS model)
 Volume from 6 months of runoff (Nov-April) = 198040 ft³ (AWM model)
 Depth of Precipitation^{evap} = 10.42 in (AWM Model)
 freeboard = 1ft

Assume: Top dimensions 195ft x 230ft
Vertical side walls

Calculations:

$$\text{Area} = w \times L = 195' \times 230' = 44850 \text{ ft}^2$$

$$\text{Direct rainfall contribution} = (\text{Precip} - \text{evap})^* \text{Area} = \frac{10.42 \text{ in}}{12 \frac{\text{in}}{\text{ft}}} \times 44850 \text{ ft}^2 = 38944.75 \text{ ft}^3$$

$$\text{Direct contribution from 25 year / 24hr storm} = \text{Precip (in)} \times \text{Area (ft}^2) = \left(\frac{4.45 \text{ in}}{12 \frac{\text{in}}{\text{ft}}} \right) \times 44850 \text{ ft}^2 = 16631.875 \text{ ft}^3$$

$$\text{freeboard} = 1 \text{ ft} \times \text{Area} = 1' \times 44850 \text{ ft}^2 = 44850 \text{ ft}^3$$

$$\text{Total volume} = (\text{Cumulative } \overset{\text{direct}}{\text{rainfall contribution}}) + (\text{Direct rainfall from (25 yr / 24hr) storm})$$

$$+ (\text{Freeboard}) + (\text{Runoff volume from 25 yr / 24hr storm})$$

$$+ \text{Cumulative runoff volume during winter (Nov-April)}$$

$$\text{Total Volume} = 38944.75 \text{ ft}^3 + 16631.88 \text{ ft}^3 + 44850 \text{ ft}^3 + 58575 \text{ ft}^3 + 198040 \text{ ft}^3$$

$$= 357042 \text{ ft}^3 \quad \text{or} \quad \underline{\underline{2,670,860 \text{ gallons}}}$$

$$\text{Depth} = \text{Volume} / \text{Area} = \frac{357042}{44850} = 8 \text{ ft}$$



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Job	Walnut Lake	Project No.	13-020064-20	Sheet No.	2
Subject	Storm Water Storage Pond	By	PCW	Date	6/17/04
		Checked By		Date	

Redesign
 Depth = 7 ft
 Width = 200 ft
 Length = ?

$$\text{Volume} = 357047 \text{ ft}^3$$

$$\text{Length} = \frac{357047}{(7)(200)} = 255 \text{ ft}$$

$$\text{Area} = 200' \times 255' = 51,000 \text{ ft}^2$$

Redesign
 Depth = 6 ft
 Width = 200 ft
 Length = ?
 Volume = 357042 ft³

$$\text{Length} = \frac{357042}{(6)(200)} = 298 \text{ ft} \sim 300 \text{ ft}$$

$$\text{Area} = 200' \times 300' = 60,000 \text{ ft}^2$$

Based on calculated areas, 6 soil borings are required during the subsurface investigation.

Required Volume for 200' x 300'

$$\text{Direct Precipitation} = \left(\frac{10.42''}{12 \frac{\text{in}}{\text{ft}}} \right) (60,000 \text{ ft}^2) = 52,100 \text{ ft}^3$$

Direct contribution from 25-year/24 hour storm

$$= \frac{4.45''}{12 \frac{\text{in}}{\text{ft}}} (60,000 \text{ ft}^2) = 22,250 \text{ ft}^3$$

$$\text{Freeboard} = 1' \times 60,000 \text{ ft}^2 = 60,000 \text{ ft}^3$$

$$\begin{aligned} \text{Total Volume} &= 52,100 \text{ ft}^3 + 22,250 \text{ ft}^3 + 60,000 \text{ ft}^3 + 58575 \text{ ft}^3 + 198040 \text{ ft}^3 \\ &= 390,960 \text{ ft}^3 = \underline{\underline{29,24,621 \text{ gal}}} \end{aligned}$$

$$\text{Required Depth} = \underline{\underline{6.52'}}$$